PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
ALEXANDER D. RARING
P.O. BOX 2266 EADS STATION
ARLINGTON, VA 22202

MAY - 5 2004

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

	Date of Mailing (*day/month/year*) 30 APR 2004
Applicant's or agent's file reference	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US03/32741	International filing date (*day/month/year*) 06 November 2003 (06.11.2003)
Applicant NANOPTICS LTD	

1. ☒ The applicant is hereby notified that the international search report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34, chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

3. ☐ **With regard to the protest** against payment of (an) additional fee(s) under Rule 40.2, the applicant is notified that:

☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

Shortly after **18 months** from the priority date, the international application will be published by the International Bureau. If the applicant wishes to avoid or postpone publication, a notice of withdrawal of the international application, or of the priority claim, must reach the International Bureau as provided in Rules 90 *bis*.1 and 90 *bis*.3, respectively, before the completion of the technical preparations for international publication.

Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Steve Griffin Telephone No. 571-272-1700

Form PCT/ISA/220 (April 2002) *(See notes on accompanying sheet)*

PATENT COOPERATION TREATY

From the INTERNATIONAL SEARCHING AUTHORITY

To:
ALEXANDER D. RARING
P.O. BOX 2266 EADS STATION
ARLINGTON, VA 22202

PCT

NOTIFICATION OF TRANSMITTAL OF THE INTERNATIONAL SEARCH REPORT OR THE DECLARATION

(PCT Rule 44.1)

	Date of Mailing (*day/month/year*) 30 APR 2004
Applicant's or agent's file reference	**FOR FURTHER ACTION** See paragraphs 1 and 4 below
International application No. PCT/US03/32741	International filing date (*day/month/year*) 06 November 2003 (06.11.2003)
Applicant NANOPTICS LTD	

1. ☒ The applicant is hereby notified that the international search report has been established and is transmitted herewith.

Filing of amendments and statement under Article 19:
The applicant is entitled, if he so wishes, to amend the claims of the international application (see Rule 46):

When? The time limit for filing such amendments is normally two months from the date of transmittal of the international search report.

Where? Directly to the International Bureau of WIPO, 34, chemin des Colombettes 1211 Geneva 20, Switzerland, Facsimile No.: (41-22) 740.14.35

For more detailed instructions, see the notes on the accompanying sheet.

2. ☐ The applicant is hereby notified that no international search report will be established and that the declaration under Article 17(2)(a) to that effect is transmitted herewith.

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☐ the protest together with the decision thereon has been transmitted to the International Bureau together with the applicant's request to forward the texts of both the protest and the decision thereon to the designated Offices.

☐ no decision has been made yet on the protest; the applicant will be notified as soon as a decision is made.

4. **Reminders**

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Within **19 months** from the priority date, but only in respect of some designated Offices, a demand for international preliminary examination must be filed if the applicant wishes to postpone the entry into the national phase **until 30 months** from the priority date (in some Offices even later); otherwise the applicant must, **within 20 months** from the priority date, perform the prescribed acts for entry into the national phase before those designated Offices.

In respect of other designated Offices, the time limit of **30 months** (or later) will apply even if no demand is filed within 19 months.

See the Annex to Form PCT/IB/301 and, for details about the applicable time limits, Office by Office, see the *PCT Applicant's Guide*, Volume II, National Chapters and the WIPO Internet site.

Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Steve Griffin Telephone No. 571-272-1700

Form PCT/ISA/220 (April 2002) *(See notes on accompanying sheet)*

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference	**FOR FURTHER ACTION**	see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.
International application No. PCT/US03/32741	International filing date (*day/month/year*) 06 November 2003 (06.11.2003)	(Earliest) Priority Date (*day/month/year*) 06 November 2002 (06.11.2002)
Applicant NANOPTICS LTD		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the Report**
   a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.
   ☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).
   b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing:
   ☐ contained in the international application in written form.
   ☐ filed together with the international application in computer readable form.
   ☐ furnished subsequently to this Authority in written form.
   ☐ furnished subsequently to this Authority in computer readable form.
   ☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
   ☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.
2. ☒ **Certain claims were found unsearchable** (See Box I).
3. ☐ **Unity of invention is lacking** (See Box II).
4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☐ the text is approved as submitted by the applicant.
   ☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No. ____
   ☐ as suggested by the applicant.
   ☐ because the applicant failed to suggest a figure.
   ☐ because this figure better characterizes the invention.
   ☒ None of the figures

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/32741

Box I Observations where certain claims were found unsearchable (Continuation of Item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claim Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claim Nos.: 1,2,22-24,27,35,46,80-82,117,118,124-127,141,142 and 189
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Please See Continuation Sheet

3. ☒ Claim Nos.: 3-21,25,26,28-34,36-38,45,47-79,83-116,119-121,128,131-134,137-140,143,153,156-158,161-164 and 166-188
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of Item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/32741

Box III TEXT OF THE ABSTRACT (Continuation of Item 5 of the first sheet)

NEW ABSTRACT

The invention is directed to inserting a fiber into a piezo tube scanner so as to create and optical focusing device. The method and device integrates between theory, characterization methodology and integrated production methodologies that allow for the control of fabrication and the generation of structures that could not be fabricated or whose fabrication could not be controlled before the realization of such integrated and interconnected methodologies of simulation, production and characterization that had not been applied to guide the fabrication techniques of micro and/or nano optical components before the inventive steps of this invention

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/32741

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7) : 37/14, 37/15
US CL : 65/387, 393, 392
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 65/387, 393, 392

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5,822,930 A (KLEIN) 20 OCTOBER 1998 (20.10.1998), figure 1.	39-44, 122-123, 129-130, 135-136, 154-155, 159-160, 165
X	US 6,260,388 B1 (BORRELLI et al) 17 July 2001 (17.07.2001), claims 1-2.	39-44, 122-123, 129-130, 135-136, 154-155, 159-160, 165
X	US 5,751,871 A (KRIVOSHLYKOV et al) 12 May 1998 (12.05.1998), figures 2 and 6.	39-44, 122-123, 129-130, 135-136, 154-155, 159-160, 165
X	US 5,845,024 A (TSUSHIMA et al) 01 December 1998 (01.12.1998), col. 3, lines 6-26.	39-44, 122-123, 129-130, 135-136, 154-155, 159-160, 165

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
22 March 2004 (22.03.2004)	
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Steve Griffin Telephone No. 571-272-1700

Form PCT/ISA/210 (second sheet) (July 1998)

PCT/US03/32741

INTERNATIONAL SEARCH REPORT

C. (Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,886,537 A (PATRICK) 12 December 1989 (12.12.1978), col. 6, line 14-39.	39-44, 122-123, 129-130, 135-136, 154-155, 159-160, 165

INTERNATIONAL SEARCH REPORT

PCT/US03/32741

Continuation of Box I Reason 2:
Present claims 1,2,22-24,27,35,46,80-82,117,118,124-127,141, and 142 relate to an extremely large number of possible methods of manufacturing a micro structure. Support within the meaning of Article 6 PCT and disclosure withing the meaning of Article 5 is to be found, however for only a very small proportion of the methods claimed. In the present case, the claims so lack support, and the application so lacks disclosure, that a meaningful search over the whole of the claimed scope is impossible. The description lacks embodiments and comparative examples, necessary for rendering plausible the presence of technical effect. Furthermore, in view of the large number of method claims presently on file, which render it difficult to determine the matter for which proctection is sought, the present application fauils to comply with the clarity and conciseness requirment of Article 6 PCT (see also Rule 6.1(a)) to such an extent that a meaningful search is impossible. Claim 189 depends from itself.

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
ALEXANDER D. RARING
P.O. BOX 2266 EADS STATION
ARLINGTON, VA 22202

OCT 4 2004

PCT

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

	Date of Mailing *(day/month/year)*
Applicant's or agent's file reference LEWIS LENS	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US03/32741	06 November 2003 (06.11.2003)	06 November 2002 (06.11.2002)

Applicant

NANOPTICS LTD

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Steve Griffin Telephone No. 571-272-1700

DEBORAH A. THOMAS
PARALEGAL SPECIALIST
~~GROUP 1800~~

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

To:
ALEXANDER D. RARING
P.O. BOX 2266 EADS STATION
ARLINGTON, VA 22202

PCT

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of Mailing *(day/month/year)*	01 OCT 2004

Applicant's or agent's file reference	**IMPORTANT NOTIFICATION**
LEWIS LENS	

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US03/32741	06 November 2003 (06.11.2003)	06 November 2002 (06.11.2002)

Applicant

NANOPTICS LTD

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2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

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For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US	Authorized officer
Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450	Steve Griffin DEBORAH A. THOMAS PARALEGAL SPECIALIST ~~GROUP 1800~~
Facsimile No. (703) 305-3230	Telephone No. 571-272-1700

Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference LEWIS LENS	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US03/32741	International filing date *(day/month/year)* 06 November 2003 (06.11.2003)	Priority date *(day/month/year)* 06 November 2002 (06.11.2002)
International Patent Classification (IPC) or national classification and IPC IPC(7): C03B 37/14, 37/15 and US Cl.: 65/387, 393, 392		
Applicant NANOPTICS LTD		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 15 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☒ Non-establishment of report with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☒ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
07 June 2004 (07.06.2004)	20 September 2004 (20.09.2004)
Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703) 305-3230	Authorized officer Steve Griffin Telephone No. 571-272-1700 DEBORAH A. THOMAS PARALEGAL SPECIALIST ~~GROUP 1300~~ Dept

Form PCT/IPEA/409 (cover sheet)(July 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/32741

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed.

☒ the description:
pages 1-29 as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

☒ the claims:
pages _____, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages 30-44, filed with the letter of 08 June 2004 (08.06.2004).

☒ the drawings:
pages 1-11, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

☐ the sequence listing part of the description:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☒ The amendments have resulted in the cancellation of:

☐ the description, pages NONE

☒ the claims, Nos. 79-189

☐ the drawings, sheets/~~fig~~ NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*
*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/32741

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The question whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been and will not be examined in respect of:

☐ the entire international application,

☒ claims Nos. 1-69, 73-77

because:

☐ the said international application, or the said claim Nos. ____ relate to the following subject matter which does not require international preliminary examination *(specify)*:

☐ the description, claims or drawings *(indicate particular elements below)* or said claims Nos. ____ are so unclear that no meaningful opinion could be formed *(specify)*:

☐ the claims, or said claims Nos. ____ are so inadequately supported by the description that no meaningful opinion could be formed.

☒ no international search report has been established for said claims Nos. 1-69 and 73-77

2. A meaningful international preliminary examination cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.

☐ the computer readable form has not been furnished or does not comply with the standard.

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/32741

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims 70-72, 78	YES
	Claims NONE	NO
Inventive Step (IS)	Claims 70-72, 78	YES
	Claims NONE	NO
Industrial Applicability (IA)	Claims 70-72, 78	YES
	Claims NONE	NO

2. CITATIONS AND EXPLANATIONS

Claims 70-72 and 78 meet the criteria set out in PCT Article 33(2)-(3), because the prior art does not teach or fairly suggest the creation of the protrusion and then shaping it to form an optical waveguide.

Claims 70-72 and 78 meet the criteria set out in PCT Article 33(4), and thus posses industrial applicability because the subject matter claimed can be made or used in industry.

---------- NEW CITATIONS ----------

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US03/32741

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the questions whether the claims are fully supported by the description, are made:

Claims 70-72 and 78 are objected to under PCT Rule 66.2(a)(v) as lacking clarity under PCT Article 6 because claims 70-72 and 78 are indefinite for the following reason(s): The preamble is directed to making a optical waveguide, but the last line refers to an optical element. One of ordinary skill would be confused as to whether they are the same things, or if they can be different. In claim 72, the claim is inaccurate because a shape cannot define a refractive index; refractive index is completely independent of shape - one would not know what is meant by this. Claim 72 there is no antecedent basis for "the near field". It is unclear if the shaping of claim 72 is in addition to the shaping of claim 70 - or if it further limits it. Claim 78: there is no antecedent basis for "the motion" and "the imaging devices".

New Claims

1. A method for producing a micro and/or nanostructure for modulating light, comprising the steps of:

providing a theoretical simulation of light modulating parameters for the structure, the simulation being based on an exact numerical calculation of fields within the structure and outside a light emitting surface of the structure;

characterizing the emitting surface of the structure by geometric and light profiling at the surface, in the near-field of the surface, and at far-field distances from the surface; and

fabricating the nanostructure emitting surface integrally with said simulation and characterization steps.

2. The method of claim 1, wherein fabricating said structure includes forming an emitting surface on the end of an optical fiber, hollow fiber, or other waveguide.

3. The method of claim 1, wherein light profiling at the emitting surface includes determining the properties of light emitted from the structure.

4. The method of claim 1, wherein geometric profiling includes scanned probe topographic imaging.

5. The method of claim 1, further including fabricating the nanostructure to produce a waveguide having a light emitting surface and guiding the fabrication by said simulation and characterization steps.

6. The method of claim 5, wherein fabricating the nanostructure includes forming the emitting surface on the end of an optical fiber, hollow fiber, or other waveguide.

7. The method of claim 6, wherein light profiling at the emitting surface includes determining the properties of light emitted from the emitting surface.

8. The method of claim 7, wherein geometric profiling includes scanned probe topographic imaging.

9. The method of claim 7, further including controlling the fabrication of said structure and said emitting surface by integrating the theoretical simulation, the characterization, and the fabrication steps.

10. The method of claim 1, further including characterizing the mode field diameter of said structure or the spot size produced by light emitted from said emitting surface for optically coupling the structure to another optical device.

11. The method of claim 1, wherein fabricating the emitting surface includes forming a lens.

12. The method of claim 1, wherein providing a simulation includes analyzing coupling efficiency, beam waist diameter and working distance taper angle for light emitted from said structure, and determining radius of curvature for said emitting surface for designing an optimal structure.

13. The method of claim 1, wherein providing a theoretical simulation includes finite element field calculations, and wherein characterizing the emitting surface includes monitoring the fabrication of the nanostructure using near-field and far-field optical characterization with scanned probe imaging.

14. The method of claim 1, wherein said theoretical simulations include interactively defining boundary conditions by near-field optics to provide said exact field calculations.

15. The method of claim 1, wherein fabricating the nanostructure includes pulling; mechanical, laser or heat polishing; etching, writing, imprinting or molding; or deposition processes.

16. The method of claim 1, wherein characterizing the emitting surface includes determining the phase properties of light within the structure and of light emitted from the emitting surface.

17. The method of claim 16, wherein characterizing the emitting surface further includes atomic force topographic imaging of the surface.

18. The method of claim 16, wherein characterizing the emitting surface further includes measuring light emitted from the surface for return loss, polarization dependent loss, and/or coupling efficiency.

19. The method of claim 1, wherein characterizing the emitting surface includes characterizing the mode field diameter, spot size, and beam waist diameter of emitted light and the working distance taper angle and radius of curvature of the emitting surface.

20. The method of claim 1, further including interactively providing said theoretical simulation, characterizing, and fabricating the emitting surface to provide micro-optical structures for emitting light at wavelengths of about 1.5μ with a waist diameter of about 1.6μ.

21. The method of claim 1, wherein the step of fabricating includes fabricating converters, couplers, multi-lens arrays and microelectro-mechanical devices.

22. The method of claim 1, wherein the step of providing a theoretical simulation includes adjusting theoretical parameters in response to the characterization of the emitting surface.

23. The method of claim 1, wherein the fabrication step is selected on the basis of said theoretical simulation and characterization steps to achieve a desired distribution of emitted light and to obtain desired topographic measurements,

far-field measurements, return loss, polarization loss, and/or coupling efficiency.

24. The method of claim 1, wherein characterizing emitted light in the near field of the emitting surface includes providing a near-field optical aperture having a diameter as small as 1/10 the wavelength of the emitted light at a distance as close as 1/10 the wavelength of the emitted light from the emitting surface, and monitoring the light passing through said aperture.

25. The method of claim 24, further including monitoring the wavefront of emitted light at multiple optical planes to determine phase properties and/or phase-based properties of the emitted light.

26. The method of claim 24, further including near-field characterization of emitted light with said near field aperture using differential interference contrast measurements.

27. The method of claim 24, further including providing, from said aperture, a stable source of light for providing a point spread function for a far-field optical imaging system.

28. The method of claim 27, further including characterizing emitted light by differential interference contrast measurement to improve resolution.

29. The method of claim 28, further including interactively determining the exact three-dimensional position of the aperture and characterizing the emitted light for each position, and adjusting the theoretical simulations to define the optical properties of the emitting surface.

30. The method of claim 1, wherein the step of fabricating includes tapering and polishing or etching a waveguide to produce said emitting surface on an end of the waveguide, said emitting surface comprising a lens having a radius of curvature and a tapering angle to focus light emitted by the waveguide, said light having a selected waist diameter.

31. The method of claim 30, wherein said waveguide is an optical fiber having a core and cladding, wherein tapering includes tapering both the core and the cladding and wherein etching or polishing alters only the cladding.

32. The method of claim 31, where tapering the core is independent of tapering the cladding, and wherein the lens parameters are dependent on core taper angle, cladding taper angle, and radius of curvature of the cladding.

33. The method of claim 30, wherein tapering of said fiber includes laser heating of the fiber with defined tension and defined cooling based on said near-field optical characterization and interactive theoretical simulations.

34. The method of claim 33, further including shaping said lens to control the focal spot of emitted light to a diameter of about 0.25μ for wavelengths of about 1.3-1.6μ.

35. The method of claim 1, wherein the step of fabricating includes pulling an optical fiber to produce an axial protrusion at the end of the fiber, and controlling the shape of the protrusion by iterative characterization of the protrusion and comparison with the theoretical simulation of the protrusion structure to form a lens.

36. The method of claim 35, wherein the step of fabrication further includes etching and thereafter melting said protrusion to modify the curvature of the protrusion to form a lens having desired parameters.

37. The method of claim 36, wherein melting includes laser ablation of fiber cladding to produce a stripped fiber.

38. The method of claim 35, wherein the fiber is fabricated to direct light exciting the fiber at an angle relative to the direction of the fiber axis.

39. The method of claim 35, wherein fabricating includes forming a cylindrical lens.

40. The method of claim 39, further including further shaping the cylindrical lens to form an elliptical lens.

41. The method of claim 35, wherein fabricating includes preserving the polarization of light emitted at said emitting surface.

42. The method of claim 35, further including stripping the fiber and thereafter selectively coating the fiber and/or lens.

43. The method of claim 42, wherein coating includes metal deposition.

44. The method of claim 42, wherein coating includes deposition of metal on said fiber and said lens, and further including forming an aperture in the metal coating on said lens.

45. The method of claim 44, wherein forming an aperture includes nanoindentation, ion beam etching, chemical etching, or femtosecond laser nonlinear ablation, or a combination thereof.

46. The method of claim 1, wherein the step of fabrication includes forming a waveguide incorporating said emitting surface at one end, said emitting surface being shaped in response to iterative theoretical simulation and characterizing to produce a lens structure.

47. The method of claim 1, wherein the step of fabrication includes forming a waveguide incorporating said emitting surface, and further including forming on said emitting surface Fresnel and/or diffractive optics.

48. The method of claim 47, wherein said fiber is moved with respect to a near-field optical tip through which a laser is directed onto said emitting surface to

alter the index of refraction at said surface with a resolution sufficient to form a Fresnel lens or a diffractive optical pattern.

49. The method of claim 47, further including altering the refractive index and/or the topography of said waveguide by laser or chemical etching, atomic force lithography or focused ion beam etching with sufficient resolution to produce said Fresnel or diffractive lens.

50. The method of claim 1, wherein the step of fabrication includes forming a waveguide having a core and having an emitting surface, and further including forming a diffraction pattern on the core to alter the index of refraction or topography of the core to focus emitted light, to compensate for light dispersion, to produce phase front correction in emitted light, to remove or impose birefringence, or to remove lens aberrations.

51. The method of claim 50, wherein forming a diffraction pattern includes:

coating an end of said waveguide core with metal and dialectric layers;

forming an aperture in said layers;

directing light through said aperture; and

manipulating the light, the thickness and number of metal and dialectric layers being matched to the wavelength of light to be manipulated.

52. The method of claim 1, wherein the step of fabricating includes forming a Bragg grating on said emitting surface.

53. The method of claim 1, wherein the step of fabricating includes forming a solid immersion lens on a high index optical fiber.

54. The method of claim 53, wherein the step of forming a solid immersion lens includes:

forming a ball on the end of the optical fiber; and

polishing the ball to produce a flat head that serves as the lens.

55. The method of claim 54, wherein forming said lens includes iteratively providing a theoretical simulation of the lens structure and characterizing the structure as it is being fabricated.

56. The method of claim 55, wherein forming said lens further includes providing diffractive optics on the lens.

57. The method of claim 1, wherein the step of fabricating includes forming a ball lens on an optical waveguide.

58. A method for characterizing a waveguide structure, comprising:

interactively measuring the refractive index of a medium; and

modifying the refractive index of said medium.

59. The method of claim 58, wherein measuring the refractive index includes imaging the passage of light in said medium.

60. The method of claim 59, wherein imaging the passage of light includes performing thermal conductivity or point thermocouple measurements.

61. The method of claim 59, wherein imaging the passage of light includes nanometric blocking in combination with far field image to detect variations in the intensity of light in said medium.

62. The method of claim 59, wherein imaging includes optical, electron optical, or ion optical imaging.

63. The method of claim 62, further including:

illuminating said medium;

correlating pixel for pixel the location on the surface of the medium of the imaging of the medium; and

comparing the measured refractive index with a theoretical simulation of the medium to obtain a refractive index profile of the medium.

64. The method of claim 62, further including:

further characterizing a light-emitting surface of said medium by light profiling in the near field; and

fabricating the light-emitting surface integrally with said imaging, with said characterizing and with simulating the parameters of the surface to provide a lens.

65. The method of claim 59, further including illuminating said medium through a near-field aperture to measure the index of refraction of the medium.

66. A method for light control in an optical waveguide, comprising:

forming a tapered hollow micropipette;

introducing a solution into the micropipette;

forming a metal nanoseed in said solution; and

growing the seed to produce a nanoparticle in the micropipette for controlling light passing through the micropipette.

67. The method of claim 66, wherein forming a nanoseed includes inserting an end of the micropipette into a liquid for initiating seed formation.

68. The method of claim 67, further including pulling the micropipette out of the liquid at a rate controlled to produce a selected nanoparticle geometry at the end of the micropipette.

69. The method of claim 66, further including inserting a cooling liquid in said micropipette for cooling said nanoparticle.

70. A method for forming an optical waveguide, comprising:

filling a micropipette with a material having a selected index of refraction;

causing a portion of said material to exit at the tip of the micropipette to produce a protrusion; and

shaping the protrusion to form an optical element.

71. The method of claim 70, further including coating the protrusion with metal and dielectric layers.

72. The method of claim 70, further including:

simulating the shape of the optical element to define its structure, refractive index, and light modulating properties;

characterizing the optical element by geometric and light profiling at the surface of the optical element in the near field of the surface and at far-field distances from the surface; and

iteratively shaping the element while simulating and characterizing its shape.

73. A method for fabricating a lens, comprising:

shaping a mold for use in forming a lens;

simulating the shape of the mold to define the structure, refractive index, and light modulating properties of the lens to be formed in the mold;

characterizing the shape of the mold by geometric and light profiling of the mold surface in the near field and the far field; and

iteratively shaping the mold while simulating and characterizing its shape.

74. The method of claim 73, further including forming multiple molds for use in fabricating a micro lens array.

75. A method for producing an optical waveguide, comprising:

simulating the parameters of the waveguide on the basis of a calculation of fields within the waveguide structure and outside a light emitting lens on the waveguide;

characterizing parameters of the lens by near-field and far-field geometric and light profiling of the lens; and

iteratively fabricating the waveguide and lens integrally with said simulating and characterizing the lens parameters.

76. The method of claim 75, wherein the waveguide is a multimode optical fiber transmitter or coupler to a single mode structure, and wherein fabricating includes forming a tapered fiber and lens having a taper angle and radius of curvature, respectively, to provide a lens focus about 12 microns from the lens surface with a waist diameter of about 3.8 microns.

77. The method of claim 75, further including:

integrating said near-field and far-field characterizing steps for testing waveguides and lenses by mounting imaging devices for motion relative to the waveguide and lens being fabricated.

78. The method of claim 71, further including modulating the motion of the imaging devices.